Utah Lake Water Quality Study

2018Utah Lake Sampling and Analysis Plan

Contents

Tables

Figures

Acronyms and Abbreviations

DEQ	Department of Environmental Quality
DPM	Designated Project Manager
DQO	Data Quality Objective
DWQ	Utah Division of Water Quality
EPA	United States Environmental Protection Agency
FPM	Field Project Manager
PARCC	Precision Accuracy Representativeness Comparability and Completeness
QA	Quality Assurance
QAPP	Quality Analysis Project Plan
QC	Quality Control
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey

SAP Revisions

Revision #1

1. **Changes in Storet Numbers (all May 2017-August 2017 data set)**
   a. **4917512** (DRY CREEK AT 7350 N (SARATOGA SPRINGS) will change to **4994804. 4994804 has a new site description** DRY CREEK AT 150 N (SARATOGA SPRINGS)
   b. **4917717** (BEER CREEK/BENJAMIN SLOUGH) will change to **4995465**
   c. **4917515** (SARATOGA SPRINGS AT CEDAR VALLEY) will change to **4994792**
   d. **4995040** TIMPANOGOS WWTP will change to **4995038**

Old Storets	Old Name	Change to this Storet	Change to this name or add this storet name	Comments:
4917512	DRY CREEK AT 7350 N (SARATOGA SPRINGS)	4994804	DRY CREEK AT 145 N (SARATOGA SPRINGS)	
4917717	BEER CREEK/BENJAMIN SLOUGH	4995465		
4917515	SARATOGA SPRINGS AT CEDAR VALLEY	4994792		
4995040	TIMPANOGOS WWTP	4995038		
		4996275	SPRING CK AT I-15 FRONTAGE ROAD	Added in September 2017
		4995230	POWELL SLOUGH WMA SOUTH OUTFALL TO UTAH LAKE	Added in September 2017
4995320	POWELL SLOUGH WMA SOUTH OUTFALL TO UTAH LAKE	4995230		Typo mistake in storet
4995210	POWELL SLOUGH WMA NORTH OUTFALL TO UTAH LAKE	4995250		Change May 2017- August 2017 data. Samples were collected at the Orem WWTP outfall

Introduction

This Sampling and Analysis Plan (SAP) was prepared by the Utah Department of Environmental Quality (UDEQ), Division of Water Quality (DWQ) for the collection of environmental samples required to conduct baseline research to investigate the conditions of Utah Lake and support ongoing research of Utah Lake. The information obtained from the implementation of this SAP will be used by DWQ staff, the Utah Lake Science Panel and researcher groups to collaboratively investigate the conditions of Utah Lake and evaluate water quality impairments by assessing physical, chemical and biological processes. This SAP will also guide DWQ staff on how to monitor for cyanobacterial blooms when they develop throughout the open waters of Utah Lake and along its beaches and other public access points on the lake.

Background

Concerns associated with elevated nutrient concentrations in Utah Lake include the growth of nuisance phytoplankton and periphyton, elevated pH, and the potential for cyanotoxins from blue-green algae. At the outset of the project in 2016, there was very little information on the cause of harmful algal bloom (HABs) or how these factors contribute to a HAB. The National Oceanic and Atmospheric Administration (NOAA) has identified HABs as a national concern because “they affect not only the health of people and marine ecosystems, but also the 'health' of local and regional economies” (NOAA, 2016).

Utah Lake was listed on Utah’s 2002 §303(d) list for exceedances of the state criteria for total dissolved solids (TDS) concentrations and the pollution indicator value for total phosphorus. A TMDL study was initiated in 2004, resulting in a validation and evaluation report (Psomas, 2005) and pollutant loading and impairment assessment report (Psomas and SWCA, 2007). Further action on the TMDL, including establishment of pollutant load reductions among anthropogenic sources, was suspended to evaluate the effects of the June Sucker recovery program’s carp removal efforts and to better understand the relationship between total phosphorus and impairments to the lake’s designated beneficial uses.

Since the Utah Lake study was completed in 2007, the subsequent ten years of focused data collection on the lake and its tributaries has allowed DWQ to evaluate in more detail the water quality effects on beneficial uses, water quality trends, and linkages to the management goals of Utah Lake. DWQ will spend 2016-2019 dedicated to confirming and validating impairments in Utah Lake by assessing chemical and biological transformations as reflected in phytoplankton, and fish abundance data to determine changes in ecosystem health. With this robust data set, DWQ will support a water quality model (developed by University of Utah researcher team) that reflects current advancements in predicting the effects of nutrients in shallow lake systems to help better identify water quality endpoints. Additionally, DWQ is dedicated to understanding the frequency, occurrence and impact of HABs in Utah Lake. DWQ has developed this work plan to evaluate the impairment on Utah Lake, develop tools that can be used to make water quality related decisions, and incorporate the work of stakeholders and partners also working on Utah Lake. This document details the steps DWQ will take in 2018 to better understand, assess and make informed management decisions to improve the health and function of Utah Lake.

This SAP defines the data quality objectives, sampling and analytical procedures, safety considerations, documentation and reporting requirements to be implemented by the DWQ for the collection of environmental samples in 2018 in Utah Lake. Further, this SAP also identifies special studies to be completed in 2018 to address the following stated objectives.

Site Description

Utah Lake is a remnant of Lake Bonneville located within Utah Valley and surrounded by the Provo-Orem metropolitan area. Utah Lake is a valuable ecological and recreational resource in Utah Valley and its beneficial uses are summarized in, Table 1. The lake is about 40 km long and 12 km wide and has a drainage area of about

7,500 square kilometers. The lake can be described as a shallow, cold, turbid, slightly-saline, eutrophic lake in a semi-arid region. It has only one river outlet, the Jordan River, which is a tributary of the Great Salt Lake. The lake elevation is set at a maximum of 1,368 m above sea level which is referred to as the “compromise elevation”. When lake levels exceed the compromise elevation, the pumps and gates on the Utah Lake pump station are left open to minimize flooding of lands adjacent to the lake.

Table 1. Classification of Utah Lake's Beneficial Uses

Classification	Beneficial Uses
2B – Recreation and Aesthetics	Infrequent primary contact recreation, secondary contact recreation
3B – Aquatic Wildlife	Warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain
3D – Aquatic Wildlife	Waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain

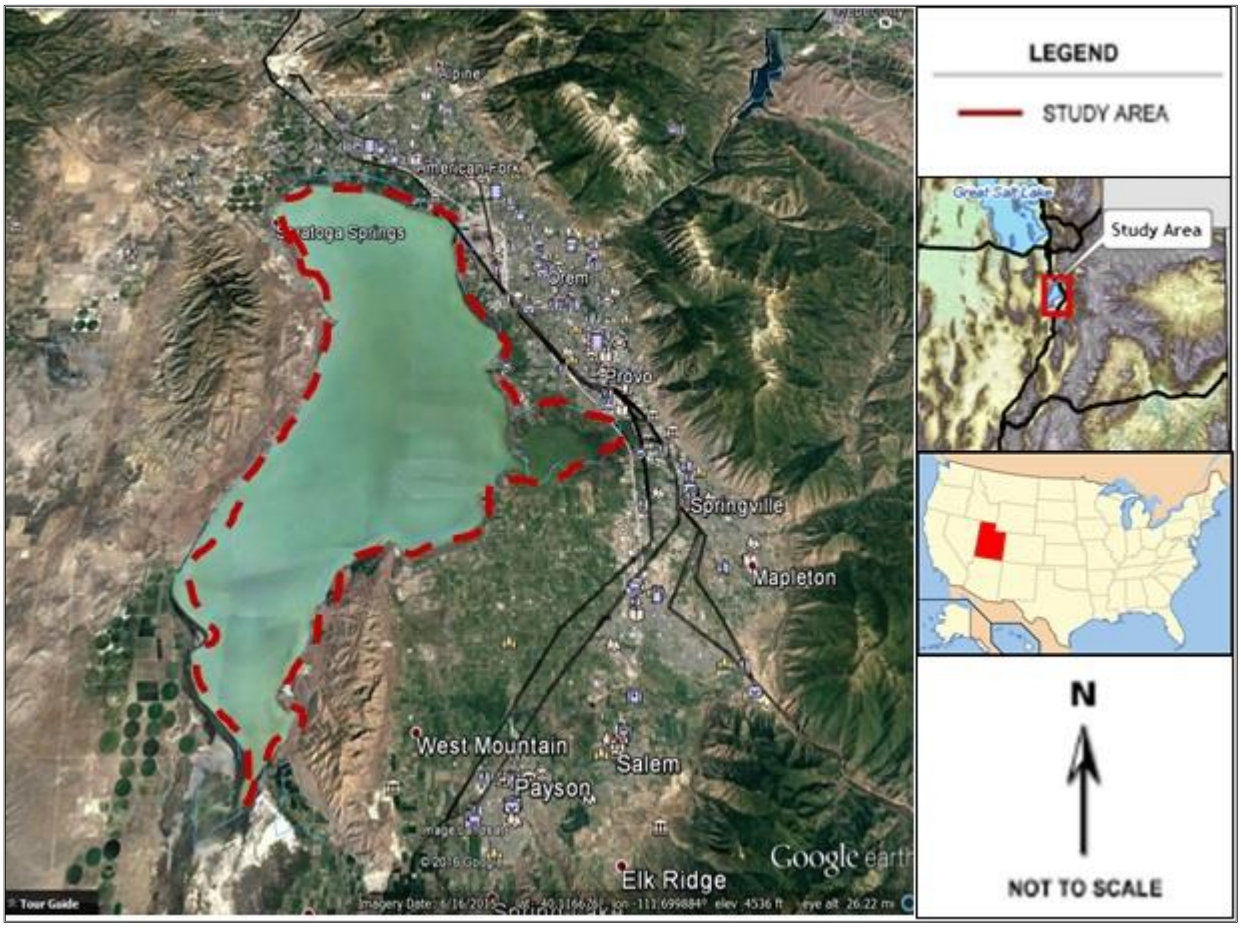


Figure 1.Study Area and Utah Lake project boundaries

Summary of Project Tasks and Schedule

The tasks associated with this preliminary survey of Utah Lake are as follows and are shown in

.

1. Develop SAP for the 2018 sampling season (spring 2018)
    a. Revise existing and potential sampling sites
    b. Finalize sampling sites
    c. Review and finalize standard operating procedures (SOPs)
2. Implement SAP (summer 2018-fall 2018)
3. Validate field and laboratory results (fall/winter 2019)
4. Analyze data and characterize sampling (fall 2018/spring 2019)

Table 2.Project Timeline

Task	2018									2019				
	Months									Months				
	04	05	06	07	08	09	10	11	12	01	02	03	04	05
Compile SAP	X	X												
Sampling Inflows	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sampling Open Waters		X	X	X	X	X	X	X						
Data Validation									X	X	X			
Data Analysis								X	X	X				
Report Writing											X	X		
Final Review													X	X

Objectives and Design of the Study

The United States Environmental Protection Agency's (EPA's) seven-step data quality objective (DQO) process (EPA, 2006) was used to guide the rationale for the 2018 Utah Lake SAP. The DQO process defines the type, quantity, and quality of data and establishes performance and acceptance criteria to make sure that the collected data supports the goals of the study.

Specific Objectives of the Study

The specific objective of this project is to collect environmental data to aid the development of an assessment method that will characterize the condition of Utah Lake. Project-level data quality objectives (DQOs) for this study are to collect data of the appropriate type, quality, and quantity to test and improve upon current sampling methods. Thus, this SAP will;

1- Support the goals of the Utah Lake Water Quality Study which include

- Understand the current water quality (nutrients, algae, and organic matter) in Utah Lake.
- Understand the nutrients loading to Utah Lake
- Support the development of a predictive water quality model
- Support the goals of the Utah Lake Science Panel

2- Target HAB forecasting

- Phytoplankton and Cyanotoxin Testing for HAB
- Real time ambient Utah Lake water quality forecast for HAB (via Sondes deployment)

DQOs are qualitative and quantitative statements derived from systematic planning that clarify the study objective, determine the most appropriate type of data to collect, determine the most appropriate conditions from which to collect the data, and specify the level of uncertainty allowed in the collected monitoring data while still meeting the project objectives. This information is summarized in Table 3.

Table 3. Data Quality Objectives.

Step	DQOs for 2018 Utah Lake Study
1. Problem Statement	Utah Lake experiences extensive algal blooms in the late summer and fall months. Prior to 2016, all the pre-existing environmental data (physical, chemical and biological data) describing the hydrology, water quality, nutrient loading and aquatic life abundance in Utah Lake was housed in different institutions and entities. To better understand the impairments and current conditions in Utah Lake, the DWQ established a holistic approach to collect and incorporate all the available information and research into a database and begin to evaluate the data. The data evaluation cycle is still ongoing. DWQ will continue to monitor and gather information which will help inform future discussions regarding the presence and significance of algal blooms and their impacts to Utah Lake.

Step	DQOs for 2018 Utah Lake Study
2. Goal of Study / Decision Statements	**Key Question[s]** 1. What are the current water quality concerns in Utah Lake? Do the current data reflect historic impairments, or new water quality impairments exist in the lake? What trends do the water quality parameters indicate? Should the water body be delisted from the current TDS and phosphorus listings based on a full assessment of current conditions? 2. What are the connections amongst the water quality parameters and effects on aquatic life? Have water quality changes coincided with changes in fish populations, macroinvertebrate populations, and phytoplankton species abundance? 3. Are the current uses of Utah Lake reflected in the current beneficial use of an infrequent primary contact (2B) waterbody? Does the recreational use survey (completed by Utah Lake Commission) support upgrading the Lake from a 2B to a frequent primary contact (2A) use? 4. What is the influence of nutrient loading, from both point and nonpoint sources, in driving the productivity of Utah Lake? How does nutrient loading vary by season and by hydrological condition? What are the current sources of nutrients, and the future expected sources, and how would changes in the nutrients affect water quality conditions of the lake? 5. What is the appropriate management goal for the lake, i.e. should the lake be clear or turbid? Has the lake ever been in a clear state, and if so, is restoration to a clear lake a desirable and achievable goal? 6. What is the quality of water, including nutrients, algae, and organic matter, that is exported from Utah Lake to the Jordan River. **Potential Outcomes** 1. Information is adequate to quantify the condition of Utah Lake and to conclude that it can qualify for beneficial use upgrade. The Utah Lake Science Panel will evaluate results and provide recommendations. 2. Information is adequate to quantify the condition of Utah Lake for determining water quality goals. 3. Information is not adequate to quantify the condition of Utah Lake or to determine whether current conditions confirm a beneficial use upgrade or nutrient criteria development. The Utah Lake Science Panel will evaluate results and provide further recommendations on how to continue the data collection process in 2018.
3. Inputs to Decision	**The following information will be collected:** Field sampling, including collection of flow rates, water chemistry and biota samples, will be conducted on monthly basis for eight months (May-December) at 16 inflow sites and seven months (May-November) for 12 Utah Lake Sites (see Table 4). ❏ Incoming flow rates and water samples will be monitored at 18 tributary sites. The data will help to identify the main nutrients inputs and estimate nutrient loads. ❏ Field measurements: Dissolved Oxygen (DO), temperature, pH and specific conductance. ❏ Water chemistry analytes: Total nutrients, total metals, 5-day biochemical oxygen demand (BOD_5), filtered nutrients, filtered metals, chlorophyll a, general chemistry (major ions, suspended solids). ❏ Phytoplankton and cyanotoxins samples: Samples will be collected monthly at the open water sites starting May 2018. These data will try to capture early bloom warnings. DWQ will also collect phytoplankton and cyanotoxins samples at designated Jordan River sites (three) to identify the spatial movement of the algal blooms. ❏ *E. coli* will be collected only at 5 beaches sites. ❏ Long term sonde deployments (ambient conditions measurements) will characterize the lake conditions. These sondes record measurements every 15 minutes and can identify anomalies in important water quality parameters (i.e., dissolved oxygen, temperature, chlorophyll, pH, phycocyanin, turbidity and specific conductance) which may help indicate early bloom warnings.

Step	DQOs for 2018 Utah Lake Study
4. Study Boundaries	The study area for this project is shown in Figure 1 **Practical Constraints on Data Collection** 1. Permit renewal for sonde deployments will need to be initiated and finalized. 2. Staff and funding availability will need to be confirmed. 3. Availability of boats and other field equipment, as well as equipment functionality, may limit some activities. 4. Weather is a major constraint for all sampling and monitoring activities, because storms can limit the ability to safely conduct sampling and measurement activities at the study area. 5. The presence of ice and/or lack of water could limit the ability to collect samples.
5. Decision Rules	The data collected under the scope of this SAP will support the goal of the study and will guide the Utah Lake Science Panel to decide whether the available data is sufficient to choose one of the two options below ; 1. Information is adequate to quantify the condition of Utah Lake or to determine whether the lake qualifies for: a) TMDL, b) Site Specific Standard and c) beneficial use upgrade, thus the Utah Lake Utah Lake Science Panel will evaluate results and provide recommendations. 2. Information is not adequate to quantify the condition of Utah Lake or to determine whether the lake qualifies for: a) TMDL, b) Site Specific Standard and c) beneficial use upgrade, thus the Utah Lake Utah Lake Science Panel will evaluate results and provide recommendations for the 2018 Utah Lake SAP.
6. Acceptance Criteria	● PARCC elements for data ▪ **Precision**—field replicates will be collected at 10 percent of sites for water chemistry variables. ▪ **Accuracy**—special efforts will be made to minimize contamination of water chemistry samples through proper collection of field samples, monitoring of sampling bottle blanks, and the use of appropriate laboratories for analysis. ▪ **Representativeness**—the sampling locations have been selected based on a review of aerial photos, and sites were chosen due to their landscape scale characteristics. Sites were chosen to encompass potentially unique characteristics of different conditions, such as water sources and potential nutrient inputs. Field sampling will occur following appropriate sample collection procedures as described in SOPs for each method. Site photos and field notes will be collected at each site and can be used to describe any unusual conditions that may occur. ▪ **Completeness**—to ensure the sampling goal of 100 percent completeness at the end of the season, we will use field reconnaissance to verify that sites have the proper hydrologic conditions. ▪ **Comparability**—all field sampling and analytical procedures will be completed following both previously tested and newly developed SOPs for each metric and will be performed by the same field crew throughout the sampling season. ● PARCC element Measurement quality objectives for chemical measurements are specified in Table 5. ● DWQ's QAPP specifies the minimum QA/QC objectives for sample measurement.
7. Sampling Plan and Design	The baseline sampling program includes the following: Field observations, collection and analysis of water (water chemistry, chlorophyll samples and *E. coli*), phytoplankton, and cyanotoxins samples for chemical, physical, and taxonomic attributes, as appropriate.

Sampling Design

As previously stated, the objective of this SAP is to assess the condition of Utah Lake. Table 4 summarizes the list of potential sampling sites. Sites are listed in the sequence they will be sampled. Every second Monday of the month, DWQ will sample the inflow sites and every second Tuesday of the month; DWQ will sample the lake sites.

Table 4. Utah Lake Priority Sites

STORET	Source	Site Name	Latitude	Longitude
4917706	Beach	Lincoln Beach Boat Harbor	40.142595	-111.802026
4917500	OW	Utah Lake 3 Mile WNW of Lincoln Beach	40.169720	-111.870830
4917710	OW	Utah Lake 1 Mile NE of Lincoln Point#03	40.157728	-111.791325
4917715	EXO	Utah Lake 1 Mile East of Bird Island	40.168100	-111.776076
4917770	OW	Utah Lake Outside Entrance To Provo Bay	40.189450	-111.731390
4917450	OW	Utah Lake At Middle of Provo Bay	40.189170	-111.699170
4917388	EXO	Utah Lake 0.5 Mile West of Provo Bay	40.237877	-111.767671
4917390	OW	Utah Lake 1 Mile West of Provo Boat Harbor	40.237220	-111.763890
4917370	OW	Utah Lake 1 Mile East of Pelican Point	40.268283	-111.829930
4917520	OW	Utah Lake 2 Mile East of Saratoga Springs #12	40.342200	-111.870550
4917310	OW	Utah Lake 0.5 mi West of Geneva Discharge #15-A	40.320920	-111.776780
4917320	OW	Utah Lake 0.5 Mile West of Geneva Discharge #15-B (4917310 Duplicate)	40.320920	-111.776780
4917365	EXO	Utah Lake 2 Mile West of Vineyard, UT	40.299558	-111.801095
4995465	IN	Beer Creek/Benjamin Slough	40.132872	-111.791490
5919910	IN	Drain At 4000 West 5000 South	40.143868	-111.749455
4995578	IN	Spanish Fork River	40.157790	-111.730756
4917702	Beach	Sandy Beach	40.170093	-111.745197

STORET	Source	Site Name	Latitude	Longitude
4996100	IN	Hobble Ck At I-15 BDG 3mi S Of Provo	40.184014	-111.647273
4996275	IN	SPRING CK AT I-15 FRONTAGE ROAD	40.189563	-111.648965
4996566	IN	PROVO STATION 6-WLA	40.201905	-111.654758
4996540	IN	Mill Race Creek At I-15 Crossing (2 Mi S Provo Courthouse)	40.203113	-111.656176
4996677	IN	Provo River	40.236941	-111.731881
4917433	Beach	Utah Lake State Park	40.238966	-111.737862
4917335	Beach	Lindon Marina	40.327123	-111.764329
4995038	IN	Timpanogos WWTP	40.337125	-111.776971
4995041	IN	Timpanogos East Tributary	40.336630	-111.776800
4994960	IN	American FK Ck 2.5mi S of AM FK City	40.343796	-111.801778
4917305	Beach	American Fork Boat Harbor	40.340721	-111.801223
4994950	IN	Spring Ck BL Lehi Mill Pond	40.363049	-111.835150
4994804	IN	Dry Creek At 145 N (Saratoga Springs)	40.365040	-111.883930
4994792	IN	Saratoga Springs at Cedar Valley	40.352421	-111.901945
Sites accessed by Airboat				
4996040	IN	Dry Creek Near Utah Lake -WLA	40.181488	-111.671552
4995210	IN	Powell Slough WMA North Outfall to Utah Lake	40.265236	-111.742791
4995230	IN	Powell Slough WMA South Outfall to Utah Lake	40.263092	-111.740668

Figure 2. Utah Lake Open Water and Beach Sites.

Figure 3. Utah Lake Inflow Sites

Parameters to Be Measured

The 2018 Utah Lake activities will aim to understand the temporal and spatial condition of Utah Lake thus it is characterized into four categories:

- Environmental sample collection: These activities will aim to understand the temporal and spatial condition of Utah Lake.
- Flow measurements
- Long-term sonde deployments
- Supplemental studies (these are studies that will be performed to address specific questions that are critical to meeting the objectives of this SAP)

To meet the requirements of the four categories mentioned above, DWQ will collect the following data;

1. Environmental samples (Water chemistry and chlorophyll-a)
2. Flow rates (cubic feet per second) at inflows
3. Water depths and Secchi depths at lake sites
4. Water surface elevation of Utah Lake
5. Phytoplankton diversity and numbers
6. *E. coli* samples
7. Cyanotoxins samples
8. Long-term sondes at three lake sites

Environmental Sample Collection

The majority of DWQ's resources will be dedicated to collecting environmental samples that describe the conditions of Utah Lake (open water sites) and inflow sites (major tributaries) to Utah Lake. This data will be critical in benchmarking the present condition and understanding what additional studies might be required to meet the objectives of the Utah Lake study. This section provides a detailed summary of the approach the DWQ will use in 2018.

Sampling Utah Lake Open Waters

Historically, DWQ has sampled eight open waters sites on Utah Lake. The 2018 field efforts and SAP will continue to monitor these sites (Table 4). Open water sites will be sampled for water chemistry, phytoplankton and Cyanotoxin samples on monthly basis. Water chemistry samples will help to understand the temporal and spatial condition of Utah Lake. Table 6 shows the chemical analytes that will be collected at these sites. The DWQ will also document observations of water depth, light penetration (secchi depth), and presence of algal mats whenever samples are collected in the open waters. Sampling procedures, analytical methods, and quality assurance requirements are found in the QAPP in Appendix G.

Sampling Tributaries (Inflows)

Hydrology will be monitored for a minimum of one year. Two major tributaries (Provo River and Spanish Fork River) account for nearly 60% of the inflow into Utah Lake by streams or rivers. The Provo River and Spanish Fork River account for 36% and 24 % of the inflow respectively. Other tributaries include the American Fork River, Current Creek, Dry Creek, Hobble Creek, and Mill Race Creek.

DWQ prioritized seventeen major tributary sites (inflow sources) (see Table 4) based on their relative flow contributions to Utah Lake. DWQ will monitor them on a monthly basis for flow and water chemistry samples as identified in Table 5 and

Table 6.

Table 5. Parameters to Be Measured.

Description		Field Method*	Details
Phytoplankton		Grab Sample Collection	* One 1800 mL bottle ***Sent to Sam Rushforth*
Cyanotoxins		Grab Sample Collection	* One 250 mL bottle ***Sent to State Lab*
Water Chemistry	Field Parameters	Multi-Parameter Probe	Temperature, Specific Conductance, pH, Dissolved Oxygen
	Exo Sondes Field Parameters	Multi-Parameter Probe	Temperature, Specific Conductance, pH, Dissolved Oxygen, Turbidity, Algae

	General Chemistry	Grab Sample Collection	* One 1000 mL bottle ** *Sent to State Lab*
	Total (unfiltered) Nutrients	Grab Sample Collection	* One 500 mL bottle with H_2SO_4 preservative ***Sent to State Lab*
	Filtered Nutrients	Filtered Sample	* One 250 mL bottle with H_2SO_4 preservative ***Sent to State Lab*
	Filtered Metals	Filtered Sample	* One 250 mL bottle, preserved with HNO_3 ***Sent to State Lab*
	Chlorophyll-*a*	Grab Sample and Field Filtering	*0.7-µm filter residue ***Sent to State Lab*
	E. coli	Grab Sample Collection	* One 125 mL bottle, contains sodium thiosulfate to neutralize chlorine

Table 6. Water Quality Parameters.

Water Chemistry Parameters to be Analyzed for <u>INFLOW Sites</u> (Monthly Monitoring)	
Field Parameters	Temperature, specific conductance, pH and dissolved oxygen,
Biochemical Oxygen Demand (BOD)	Carbonaceous BOD_5 ($cBOD_5$) only at Wastewater Treatment Plants
Non-filtered Nutrients	Ammonia, Nitrate/Nitrite, Total Phosphorus, Total Nitrogen, and TOC
Dissolved (Filtered) Nutrients	Ammonia, Nitrate/Nitrite, Total Dissolved Nitrogen, DOC, Dissolved Phosphate
General Chemistry	Sulfate, alkalinity, turbidity, specific conductance, total suspended solids, volatile suspended solids, total dissolved solids, chlorine
Other	Chlorophyll-a, *E.*coli
Water Chemistry Parameters to be Analyzed for Utah Lake <u>Open Water Sites</u> (Monthly Monitoring)	
Field Parameters	Temperature, specific conductance, pH, dissolved oxygen, and secchi depth
EXO Sonde Parameters	Temperature, specific conductance, pH, dissolved oxygen, turbidity, chlorophyll *a* and phycocyanin
Non-filtered Nutrients	Ammonia, Nitrate/Nitrite, Total Phosphorus, Total Nitrogen, and TOC
Dissolved (Filtered)	Ammonia, Nitrate/Nitrite, Total Dissolved Nitrogen, DOC, Dissolved Phosphate

Nutrients	
General Chemistry	Sulfate, alkalinity, turbidity, specific conductance, total suspended solids, volatile suspended solids, total dissolved solids, chlorine
Filtered metals	Calcium, Magnesium, Potassium, and Sodium
Others	Chlorophyll-a, *E*.coli
NOTES: DOC= Dissolved Organic Carbon TOC= Total Organic Carbon	

Testing for HAB

In 2016, DWQ reported an unusually large algal bloom with elevated cyanobacteria cell densities occurring throughout the lake including open waters, beaches and harbors, and flowing into the Jordan River. Initial sampling and analysis confirmed a cyanobacteria bloom including taxa with the potential to produce three multiple cyanotoxins (Anatoxin a, Cylindrospermopsin and Microcystin). As a result, the DWQ collected opportunistic phytoplankton and toxin samples at Utah Lake open water sites (see Table 4) with active algal blooms and few site in the Jordan River below Utah Lake. These samples were collected as directed by the Division's standard operating procedure (SOP) for phytoplankton collection during algal blooms (see section 4). Figure 4 shows the Utah Lake HAB Monitoring Locations for 2016. In 2018, DWQ will continue to routinely and adaptively sample beach and harbor sites (see Table 4) for cyanobacteria cell count concentrations to be able to track the bloom.

Phytoplankton and Cyanotoxin samples for HAB

The primary purpose is to observe and quantify areas of cyanob2018acteria blooms, including the occurrence of surface scums. In 2018, DWQ will continue to collect phytoplankton and toxin samples from these locations (see Table 7). If HAB observations shift, DWQ will assign new monitoring locations to capture any new active algal bloom.

Sondes deployment for HAB early warning system

The objective of this special study is to characterize diurnal variations in temperature, pH, specific conductance, and dissolved oxygen in the open waters sites. In addition, these buoys will serve as an early warning system for identifying potential increases in cyanobacteria to guide HAB sampling to protect human health. DWQ will coordinate a long-term (~seven months) sonde deployment at representative locations (see Table 4 for 2016, 2017 and 2018 deployments). EXO Sondes will be located at three locations (see Table 4) and will record dissolved oxygen, pH, specific conductivity, water temperature, turbidity, chlorophyll *a*, and phycocyanin near the in the photic zone. Deployments will aim to capture critical times between July-September.

DWQ will collect phytoplankton and Ch-*a* samples at three locations to verify sonde readings and to track the strength and movement of potential blooms (see Table 7). These samples will be collected at each of the three buoys at weekly intervals to develop a statistical relationship between sonde BGA and chlorophyll a, respectively. Table 7 shows the frequency, locations, responsible organization, and associated laboratory for phytoplankton and chlorophyll a analysis associated with this effort. The budget for this sampling is presented in Table 8.

Table 7. HAB Buoy Parameters, frequency, locations and responsible organizations.

Parameter	Frequency	Sites	Samples per Site	Field Collection	Lab Analysis
Phytoplankton	Weekly	4917388, 4917715, 49717365	1	BYU	Rushforth Phycology
Chlorophyll a	Weekly	4917388, 4917715, 49717365	6	BYU	Utah Public Health Lab

Table 8. Buoy Verification Budget.

Parameter	Sites	Samples per Site	Collection Events (n)	Total Samples	Cost Per Sample	Total Cost	Analysis Contract
Phytoplankton	4917388, 4917715, 49717365	1	21	63	$175	$11,025	SUVMWA Task Order 1
Chlorophyll a	4917388, 4917715, 49717365	6	21	378	$???	Utah Public Health Lab	DWQ/UPHL Allocation

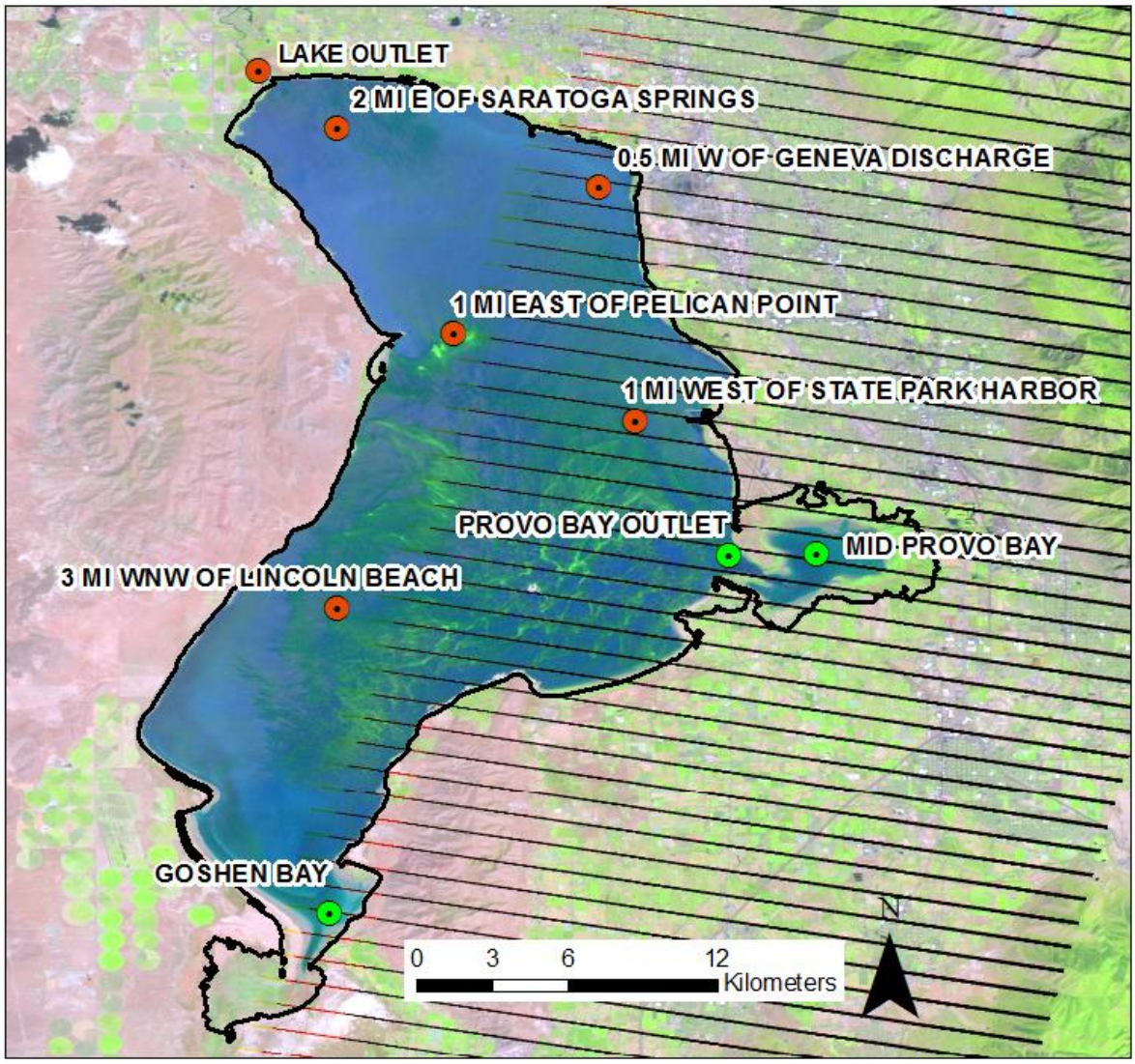


Figure 4. Utah Lake HAB Monitoring Locations (2016).

The detailed layout of the 2018 SAP is summarized in Table 9. DWQ will follow this SAP from 2018 through 2019 to better understand, assess and make informed management decisions to improve the health and function of Utah Lake. Table 9 provides a summary of site locations and activities to be completed at those locations. Water samples will be collected at a monthly interval at all inflow/tributaries and open water locations (HAB and sonde sites) identified in Table 9. Open water locations will be sampled routinely on a monthly basis every Tuesday. This will ensure adequate collection, shipment, and laboratory procedures. Tributary sites will be samples on a monthly basis every Wednesday and Thursday.

Table 9. Summary of Sampling Locations, Activities, and Frequency.

Sample Location				Flow	Water Chemistry	Phytoplankton Sampling	Cyanotoxin Sampling	Ch-a Sampling	EXO Sondes	*E. coli*
Storet ID	Site Description	Latitude	Longitude	C or I	Monthly	Monthly	Monthly	Monthly	Long-Term	Monthly
					May-November	May-November	May-November	May-November	May - November	May - November
OPEN WATER SITES and HAB										
4917600	Utah Lake Goshen Bay Southwest End	40.060235	-111.874384	NA	X	X	X	X	--	X
4917500	Utah Lake 3 Mile WNW of Lincoln Beach	40.169720	-111.870830	NA	X	X	X	X	--	X
4917710	Utah Lake 1 Mile NE of Lincoln Point#3	40.157728	-111.791325	NA	X	X	X	X	--	X
4917770	Utah Lake Outside Entrance To Provo Bay	40.189450	-111.731390	NA	X	X	X	X	--	X
4917450	Utah Lake At Middle Of Provo Bay	40.189170	-111.699170	NA	X	X	X	X	--	X
4917390	Utah Lake 1 Mile West Of Provo Boat Harbor	40.237220	-111.763890	NA	X	X	X	X	--	X
4917370	Utah Lake 1 Mile East Of Pelican Point	40.268283	-111.829930	NA	X	X	X	X	--	X
4917520	Utah Lake 2 Mile East Of Saratoga Springs #12	40.342200	-111.870550	NA	X	X	X	X	--	X
4917310	Utah Lake 0.5 Mile West Of Geneva Discharge #15-A	40.320920	-111.776780	NA	X	X	X	X	--	X
4917320	Utah Lake 0.5 Mile West Of Geneva Discharge #15-B	40.320920	-111.776780	NA	X	X	X	X	--	X
SONDE SITES and HAB										
4917715	Utah Lake 1 Mile East Of Bird Island	40.16810 0	-111.776076	--	X	X	X	X	X	X
4917388	Utah Lake 0.5 Mile West Of Provo Marina	40.237877	-111.767671	--	X	X	X	X	X	X

4917365	Utah Lake 2 Mile West Of Vineyard, UT	40.299558	-111.801095	--	X	X	X	X	X	X
HARBOR/BEACH SITES and HAB										
4917706	Lincoln Beach Boat Harbor	40.142595	-111.802026	--	--	--	--	--	--	X
4917702	Sandy Beach	40.170093	-111.745197	--	--	--	--	--	--	X
4917433	Utah Lake State Park	40.238966	-111.737862	--	--	--	--	--	--	X
4917335	Lindon Marina	40.327123	-111.764329	--	--	--	--	--	--	X
4917305	American Fork Boat Harbor	40.340721	-111.801223	--	--	--	--	--	--	X
4917385	Utah Lake American Fork Beach	40.342291	-111.802863							X
TRIBUTARIES										
Sample Location				**Flow**	**Water Chemistry**	**Phytoplankton Sampling**	**Cyanotoxin Sampling**	**Ch-a Sampling**	**EXO Sondes**	***E. coli***
Storet ID	**Site Description**	**Latitude**	**Longitude**	**C or I**	**Monthly**	**Monthly**	**Monthly**	**Monthly**	**Long-Term**	**Monthly**
				C	**May-December**	**May-December**	**June-October**	**June-October**	**May - November**	**May-December**
4995465	Beer Creek/Benjamin Slough	40.132872	-111.791490	**PT**	X	--	--	X	--	X
5919910	Drain At 4000 West 5000 South	40.143868	-111.749455							
4995578	Spanish Fork River	40.157790	-111.730756	**USGS**	X	--	--	X	--	X
4996100	Hobble Ck At I-15 BDG 3mi S Of Provo	40.184014	-111.647273	**USGS**	X	--	--	X	--	X
4996275	Spring Ck At I-15 Frontage Road	40.189563	-111.648965	**PT**	X	--	--	X	--	X
4996566	Provo Station 6-WLA	40.201905	-111.654758	**PT**	X	--	--	X	--	X

4996540	Mill Race Creek at I-15 Crossing (2 mi S Provo Courthouse)	40.203113	-111.656176	**PT**	**X**	--	--	**X**	--	**X**
4996677	Provo River	40.236941	-111.731881	**USGS**	**X**	--	--	**X**	--	**X**
4995038	Timpanogos WWTP	40.337125	-111.776971	**WWTP**	**X**	--	--	**X**	--	**X**
4995041	Timpanogos East Tributary	40.336630	-111.776800	**NA**	**X**	--	--	**X**	--	**X**
4994960	American FK Ck 2.5mi S of AM FK City	40.343796	-111.801778	**USGS**	**X**	--	--	**X**	--	**X**
4994950	Spring Ck BL Lehi Mill Pond	40.363049	-111.835150	**PT**	**X**	--	--	**X**	--	**X**
4994804	Dry Creek At 145 N (Saratoga Springs)	40.365040	-111.883930	**PT**	**X**	--	--	**X**	--	**X**
4994792	Saratoga Springs at Cedar Valley	40.352421	111.901945	**PT**	**X**	--	--	**X**	--	**X**
4995210	Powell Slough WMA North Outfall to Utah Lake	40.265236	-111.742791	**WWTP**	**X**	--	--	**X**	--	**X**
4995230	Powell Slough WMA South Outfall to Utah Lake	40.263092	-111.740668	**NA**	**X**	--	--	**X**	--	**X**
4996040	Dry Ck Near Utah Lake-WLA	40.181488	-111.671552	**PT**	**X**	--	--	**X**	--	**X**

Hydrology Study

The objective of the hydrologic study is to better understand the sources nutrients and timing of water into and through the water body. This study will identify and locate the major sources of inflows and then estimate the timing and volume of inflow and outflow of Utah Lake, and evaluate how the volume (i.e., water level and areal extent of water surface) of water in Utah Lake respond to these characteristics. Much of this data will be used to estimate nutrient loads, evaluate changes in the lake habitat (i.e., phytoplankton and zooplankton abundance) and translate how the lake responds to nutrient inputs.

The hydrologic study will focus on collecting data in two areas:

- Inflows measurements
- Water level measurement

Measurement of Flows

While continuous measurement of every inflow point is not feasible, a significant effort will be undertaken to characterize the timing and volume of the surface water inflows to Utah Lake. This study will not address groundwater inflows or outflows. DWQ will use available flow instruments for flow measurements. Sontek/YSI FlowTracker Handheld-ADV® can be used for wadeable sites and/or StreamPro ADCP (also referred to as a Q-boat) can be used for non-wadeable tributary sites.

Pressure Transducers

In 2018 (March), DWQ's personnel investigated major tributary locations. The DWQ decided to deploy pressure transducers at 10 major tributaries to ensure continuous flow monitoring using the SOP for Pressure Transducer installation and maintenance. The goal of this task is to be able to collect as much flow information as possible. Then, the one can develop a **rating curve** (relationship of discharge versus stage as a graph) for a given point on a stream. As mentioned in the paragraph above, field crews will measure stream discharge across the stream channel using a flow meter or a Qboat.

Water Level Measurement

The dynamics of how Utah Lake responds to inflows is important to understanding the areal extent of the overall water body. Periodically and mostly in the summer months, the DWQ cannot access certain open water sites because of shallow water levels. Such locations in the lake warm up much faster than other sites and might undergo faster nutrient transformations. Shallow, warm, nutrient rich water can be suitable for the initiation of a HAB event.

Outflow Measurement

The lake elevation is legally compromised at 1,368 m above sea level. When lake levels exceed the compromise elevation, the pumps and gates on the Utah Lake pump station are left open. To be able to estimate the export of nutrients from Utah Lake to Jordan River, the DWQ will periodically request pump capacity data from the Utah Lake pump station personnel to track water release dates and volumes.

Bacteriological Examination

Background Information

Escherichia coli, or *E. coli* is a type of bacteria commonly found in the intestines and feces of healthy warm-blooded animals. *E. coli* is a reliable indicator of the presence of fecal contamination and other possible disease-causing pathogens in water. *E. coli* comes from human and animal waste from sources such as improper waste dumping, faulty septic tanks or sewer systems, domesticated animals—such as dogs and livestock, large concentrations of waterfowl and other wildlife, and stormwater runoff. Pollution of all kinds, including *E. coli*, are typically higher after rainstorms since water draining into streams and lakes travels over lawns, farm fields, sidewalks, and streets which may all be sources of fecal contamination.

UDWQ uses *E. coli* concentrations to determine if waterbodies are meeting recreational and drinking water beneficial uses for microbial pathogens as articulated in Utah Administrative Code R317-2-7.1.b. UDWQ informs local health departments if monitoring results indicate *E. coli* concentrations are exceeding water quality standards.

Different waterbodies have different numeric criteria based on their beneficial use. All waters of the State are protected for contact recreation (Class 2A and 2B), and some waters are classified as drinking water sources (Class 1C). Class 2A waters are protected for frequent primary contact, while Class 2B waters are protected for infrequent primary contact. Utah's numeric criteria for *E. coli* are outlined in the Table 10 below.

Table 10.Numeric criteria for E.coli

Parameter: *E. coli*	Domestic Source (1C)	Recreation and Aesthetics (2A)	Recreation and Aesthetics (2B)
30-DAY GEOMETRIC MEAN (No./100 ml)	206	126	206
MAXIMUM (No. /100ml)	668	409	668

High levels of *E. coli* were detected in 2016 and 2018 at Lindon Marina, Sandy Beach, and Utah Lake State Park and the cause/source was not found. The primary goal of this SAP is to investigate the conditions of Utah Lake and evaluate water quality impairments by assessing physical, chemical and biological processes. This goal will be achieved through completion of the following objectives:

1. Conduct routine *E. coli* monitoring to characterize E. coli concentrations on and around the lake (Table 9).

Table 11. *E. coli* monitoring locations for Lindon Drain and Sandy Beach source characterization.

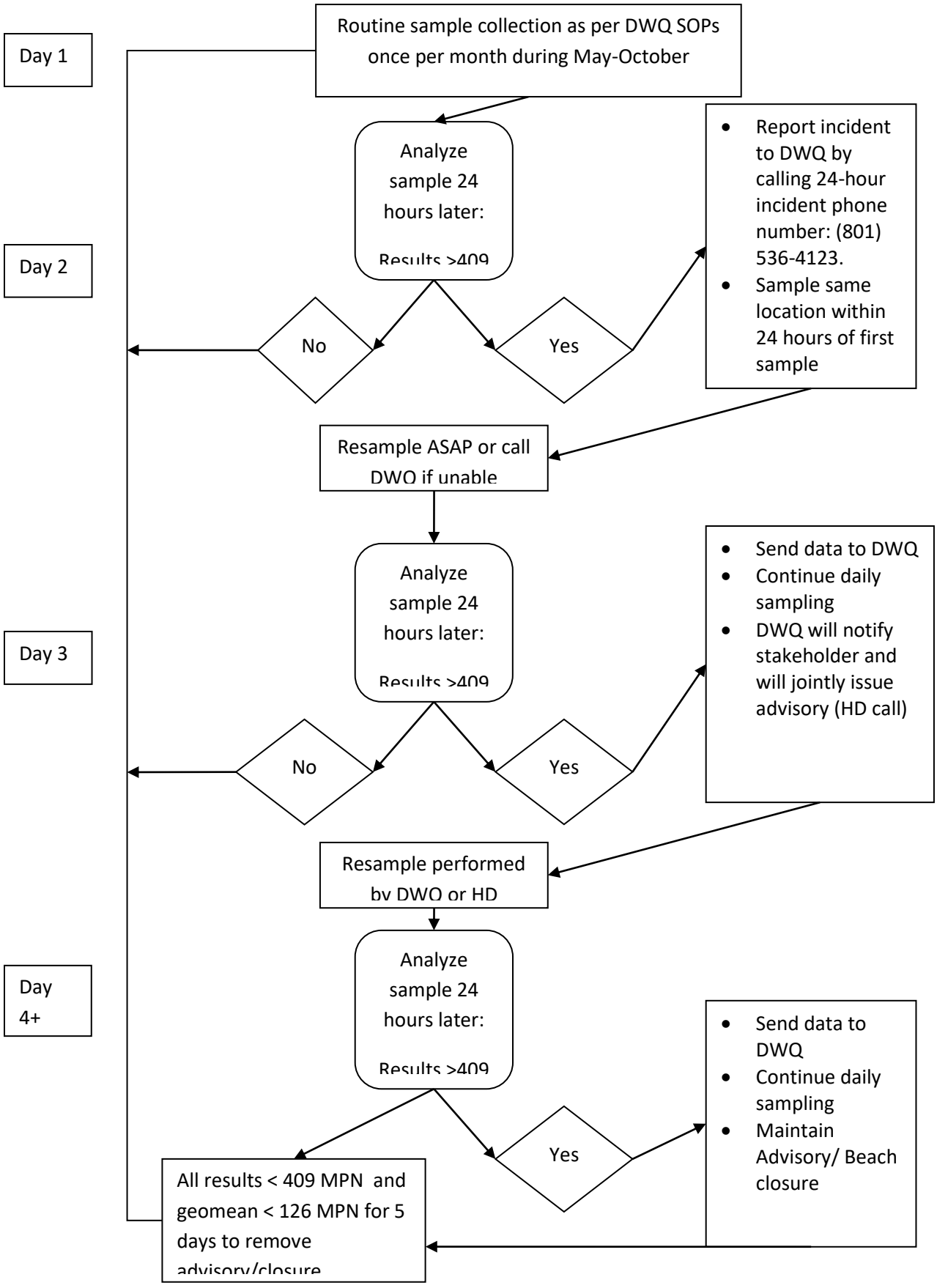
Sample Location				*E. coli* (IDEXX)	Flow	In Situ PT	Optical Fluorescence	MST	Surfactant	Caffeine
MLID	Site Description	Longitude	Latitude	Bi-weekly	Bi-weekly	15 min.	Bi-weekly	Bi-weekly	*Biweekly*	*Bi-weekly*
Lindon Drain										
4917335	Utah Lake @ Lindon Marina	-111.76429	40.327081	X						
4917333	Utah Lake North of Lindon Marina	-111.76529	40.32947	x						
4995120	LINDON DRAIN AT CO RD XING AB UTLAKE	-111.76304	40.33189	x	x	x	x	X	X	x
4995132	Unknown Inflow #6 above Lindon Drain	-111.75982	40.333619	x	x		x	X	x	X
4995128	Lindon Hollow Drain AB 200 South culvert, Lindon	-111.7589183	40.33360001	x	x		x	X	x	x
4995104	Lindon Hollow Drain, west branch abv confl.	-111.755879	40.351458	x	x		x			
4995105	Lindon Hollow Drain, east branch abv confl.	-111.755788	40.351572	x	x		x			
4995138	Lindon Drain btw 1000 W and RR tracks @ 335 N	-111.7407765	40.34432142	x	x		x			
4995130	Lindon Drain AB 200 South culvert, Lindon	-111.7585531	40.33357538	x	x		x	x	x	x
4995140	Lindon Drain at 600 N and Geneva Rd	-111.740576	40.349296	x	x		x			

4995084	Unknown Inflow #1 above Lindon Drain	-111.758844	40.333294	x	x		x	x	x	X
4995082	Marsh Inflow to Lindon Drain above 4995120	-111.759228	40.333089	x	x		x	x	x	x
4995125	Lindon Pond Outlflow	-111.753392	40.330239	x	x		X			
Sandy Beach										
4917702	Utah Lake @ Sandy Beach	-111.745876	40.171116	X				x	x	X
4995578	Spanish Fork River ab Utah Lake	-111.748753	40.167108	x	x	x	x	x	x	X
5919910	Drain at 4000 West 5000 South	-111.7493803	40.13717854	x	x	x	x	x	x	X
5919905	Bateman Drain	-111.746757	40.156109	x	x	x	x	x	x	X

E. coli Sample Collection and Processing

Personnel will use DWQ's SOPs for E. coli sample collection and processing [1-Standard Operating Procedure For Collection And Handling of E. coli Samples and 2-Standard Operating Procedure For Escherichia Coli (*E. coli*) And Total Coliform Quantification Using The Idexx Quanti-tray/2000 System]. The field crew will also follow the Beach Advisory Protocol for 2A and 2B Waters (see Figure 5). All field scientists involved with sample collection and analysis will complete a demonstration of capabilities and submit certification. This certification will be maintained with the project files and associated dataset.

Beach Advisory Protocol for 2A Waters



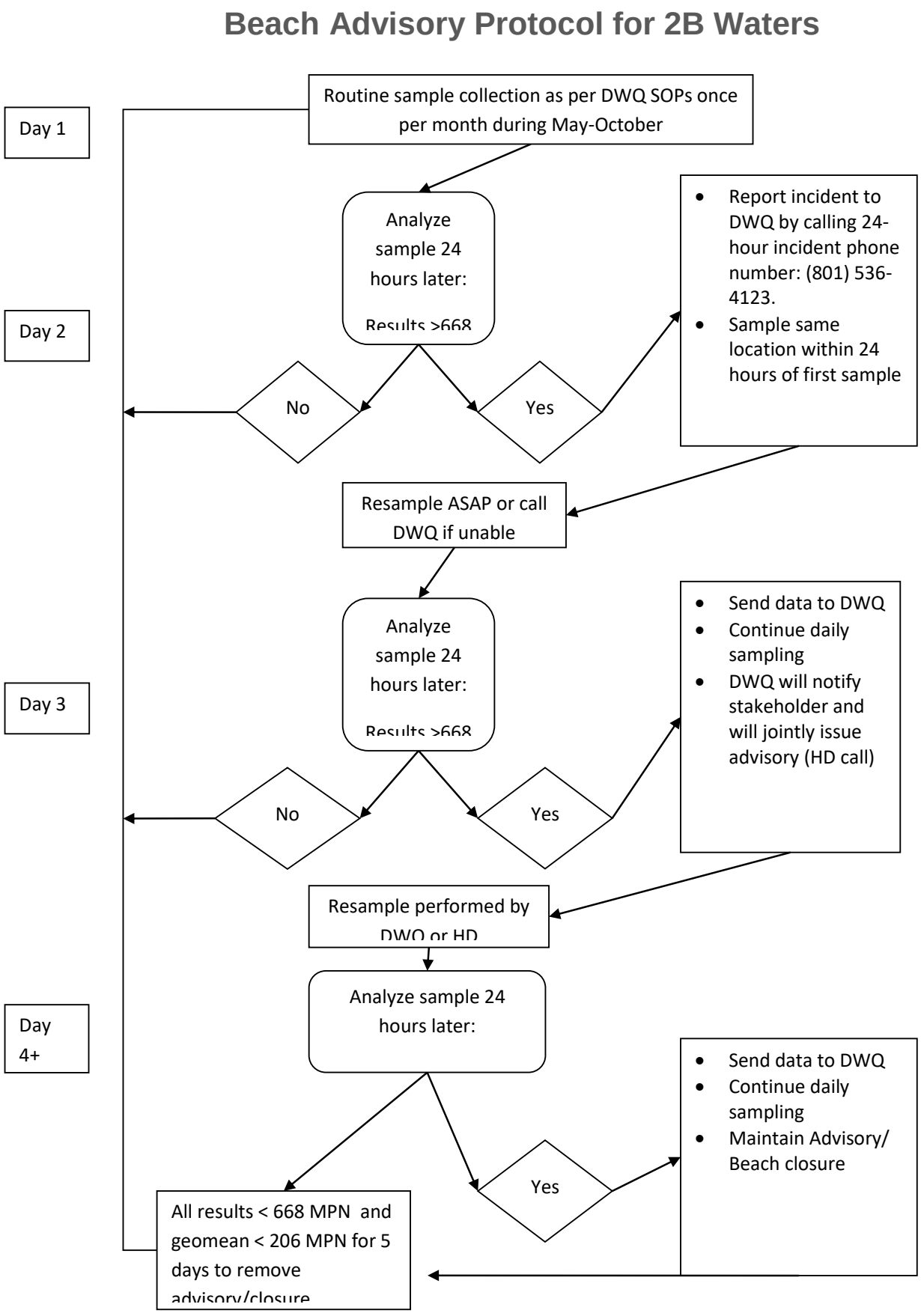


Figure 5. Beach Advisory Protocol for 2A and 2B Waters.

Project Team and Responsibilities

As defined by DEQ's Quality Management Plan (QMP), any monitoring activity conducted or overseen by DWQ must have a Designated Project Manager (DPM), a staff member who is responsible for a specific project and has immediate managerial or technical control of the project (see Table 12). The DPM is responsible for specifying the quality of the data required for each project and initiating corrective actions when quality control is not being met. The DPM may also be a program manager. The DPM is responsible for designing monitoring strategies, setting project-specific data quality objectives (DQOs), and developing project-specific SAPs. DPMs are responsible for making sure all personnel involved with the project are briefed and/or trained on the procedures to be used.

Any monitoring activity conducted or overseen by DWQ must also have Field Project Manager (FPM).The FPM will be responsible for checking the field note forms, data collection sheets, field lab sheets/Chain of Custody (COCs) forms for completeness. These sheets will be checked for completeness within 72 hours (or within a week of sample collection). Field notes will be filled out in the field for all sites whether samples were taken. Any information missing from field forms will be verified by the field crew. A list of missing samples or data will be provided to the DPM for data tracking purposes. After the data sheets are reviewed for completeness, all data will be scanned and entered into an electronic worksheet files for storage in the "Utah Lake\Phase 1.Utah Lake Project Management Files\2_Data Management & Monitoring" folder in WQ's "TMDLs Files" folder on the shared drive, which is backed up daily. When entered into an electronic worksheet, the person who enters the data will double check the information for errors and save the files, so they can be reviewed by the FPM and/or QA Project Manager for quality.

Implementation of the SAP will require an interdisciplinary effort. The team who will implement the SAP consists of various members from UDWQ (see Table 12). Table 12 also lists and identifies the key project personnel and their responsibilities. The overall efforts will be coordinated closely with other ongoing research groups and stakeholders under the oversight of the Utah Lake Science Panel.

Table 12. Project Team Members and Contact Information.

Title	Name	Organizational Affiliation	Key Tasks or Responsibilities	Contact Information	
				E-mail	Phone
Designated Project Manager	Scott Daly	DWQ	Oversees direction of project, data analysis, reporting	sdaly@utah.gov	w: 801-536-4333
Field Project Manager	Suzan Tahir	DWQ	Directs day-to-day work of project, performs field data collection	stahir@utah.gov	m: 309-868-2834 w: 801-536-4341
Field Crew	Brent Shaw	DWQ	Performs field data collection	bdshaw@utah.gov	w: 801-536-4366
HAB Coordinator	Ben Holcomb	DWQ	Supervises the HAB monitoring team	bholcomb@utah.gov	w: 801-536-4373
Lakes Assessment Coordinator	Jake Vander Laan	DWQ	Oversees direction of project, data analysis, reporting	Jvander@utah.gov	w: 801-536-4350
Quality Assurance	Toby Hooker	DWQ	Oversees QA for Division, responds	tobyhooker@utah.gov	w: 801-536-4289

Title	Name	Organizational Affiliation	Key Tasks or Responsibilities	Contact Information	
				E-mail	Phone
(QA) Project Manager			to QA issues, supervises monitoring team		
Database Manager	Lenora Sullivan	DWQ	Manages the database	lenoras@utah.gov	w: 801-536-4367
Environmental Health Scientist	Craig Bostock	UCEH	*E. coli* analysis	craigsb@utahcounty.gov	801- 851-7076
E. coli coordinator	Calah Worthen	DWQ	*E. coli* analysis	calahworthen@utah.gov	w: 801-536-4376

Field Activities

Day-to-day field operations will be overseen by Suzan Tahir, an experienced member of the DWQ Monitoring and Reporting Section (Brent Shaw). She has previous experience monitoring Great Salt Lake. The monitoring team will consist of Suzan Tahir and Brent Shaw.

Field/Lab Sheets and COCs

Preprinted field sheets and the associated lab sheets (Appendix A and Appendix B respectively) will be used on the Utah Lake monitoring run. Field measurements are recorded in the field sheets as part of each run. Hard copies are kept in a binder at UDWQ. The field measurements are entered into an excel spreadsheet and uploaded to the UDWQ AWQMS data base. Field measurements include stream flow, temperature, pH, dissolved oxygen, total depth, Secchi depth and specific conductivity. Photos will be taken at each site. *E. coli* results will be recorded on bench sheets kept for 5 years and entered into AWQMS.

All field and lab data and paperwork will include a unique Trip ID: UT LK (mm/dd/yy) or UT LK 031417 reflects a sample collected on March 14th, 2017. The Project Code for this study will be 302.

Field Sampling Methods

This section summarizes the methodology for environmental sample collection at the sites and incorporates the DQOs outlined in previous sections, the safety precautions and workflow.

Field protocols

This section provides a brief overview of the field sampling activities to be performed at each site. Specific instructions, including required equipment and procedures, are located in the SOPs.

SOP for phytoplankton collection during algal blooms
https://deq.utah.gov/Divisions/dwq/health-advisory/harmful-algal-blooms/docs/SOP-HAB-Phytoplankton-Samples-2016.pdf

SOP for Water Chemistry Sample Collection
https://deq.utah.gov/ProgramsServices/programs/water/wetlands/docs/2014/05May/SOP_WaterChem-SampleCollection_091011_WetL.pdf

SOP For Filtering Water Column Chlorophyll-a Samples
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_Chlorophyll-a_5.21.13_Rev1.pdf

SOP for *E. coli* collection
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_EcoliSampleCollection_5.1.14_Rev1.2.pdf

SOP for *E. coli* analysis
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_EcoliSampleAnalysis_5.1.14_Rev%201.2.pdf

SOP For Pressure Transducer Installation and Maintenance
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_PressureTransducers_5.1.14_Rev0.pdf

SOP For Calibration, Maintenance, And Use Of Hydrolab Multiprobes
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_Hydrolabs_5.1.14_Rev0.pdf

SOP For Stream Flow Measurement
https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/SOP_StreamFlow_5.1.14_Rev0.pdf

Health and Safety

Safety must be a primary concern at all times and in all sampling situation for field sampling personnel. In any marginal or questionable situation, monitoring personnel (monitors) are required to assume worst case conditions and use safety precautions and equipment appropriate to that situation. Monitors who encounter conditions which in their best professional judgment may exceed the protection of their safety equipment or may in any way represent a potential hazard to human health and safety, should immediately leave the area and contact their supervisor.

There must be a minimum of two sampling personnel present in the field. To avoid direct contact with contaminated water, latex or rubber gloves will be worn when sampling surface water. Monitors will wash hands and arms thoroughly with bacterial soap after sampling or before eating and drinking. Monitors should be familiar with basic first aid and cardiopulmonary resuscitation (CPR).

Monitors are strongly encouraged to carry a cell phone. Monitors will inform a supervisor when they leave for the field and their estimated time of return. The supervisor will initiate an emergency action plan if the samplers have not returned to the office within the allocated time. To avoid unnecessary worry and concern, samplers will call the office if they are behind schedule.

Safety Precautions and Plan

Field personnel will take appropriate precautions when operating watercraft and working on, in, or around water; possibly steep or unconsolidated banks; or edges of ponds. All field crews will follow appropriate safety procedures and be equipped with safety equipment such as proper wading gear, gloves, first aid kits, cellular phone, etc. All boats should be equipped with safety equipment such as personal floatation devices, oars, air horn, etc. Utah's Boating Laws and Rules shall be followed by all field personnel.

Field personnel will be aware that hazardous conditions potentially exist at every water body. If unfavorable conditions are present at the time of sampling, it is recommended for staff to reschedule the sample visit. If hazardous weather conditions arise during sampling, such as lightning or high winds, personnel should cease sampling and move to a safe location.

Most often, sample bottles are prepared by the State Lab and already contain preservative. During packing and handling of bottles, the field personnel must be careful and should confirm that caps are tightly sealed in order to avoid contact with preservative (acid). If minor skin contact occurs, field personnel should rinse with copious amounts of water. If major skin or internal contact occurs, affected personnel should seek medical attention.

Monitors should take care to reduce the possibility to contracting diseases carried by insect vectors such as West Nile virus (mosquitoes) and tularemia (horse flies). Other factors to consider are dehydration, weather exposure, stings, and potential site access issues such as barbed-wire fences, broken glass, steep slopes, and mud.

Equipment

Equipment Testing, Inspection, and Maintenance

DWQ field monitors will inspect all sampling equipment before every sampling event. Equipment maintenance will be scheduled and completed based on these inspections and review of the collected data. The QA Project Manager will regularly review all calibration and maintenance records, so the minimum required maintenance occurs. Detailed procedures for maintenance of equipment are provided in the corresponding SOPs.

The designated laboratories for this project will be responsible for and expected to follow their laboratories or manufacture's standard procedures for preventative/unscheduled maintenance, calibration, and correction action for all laboratory instruments. DWQ is not responsible for the maintenance of the designated laboratories' equipment.

Equipment Calibration and Frequency

Each instrument will be calibrated according to in-house and manufacture recommendations and at the frequency recommended by the manufacturer. However, water quality probes will be calibrated before each sampling event and in the field if any errors occur while sampling. Calibration procedures will be documented on a calibration sheet (see Appendix E) , which includes the location, date, and time of calibration, initials of the person performing the calibration, reference standard used (if applicable), readings taken and adjustments to attain a proper reading, and any corrective action. Records of calibration sheets will be stored electronically and backed up daily; hardcopies will be filed in the project binder in DWQ's QA Project Manager's office.

Table 13. Sample Quality Control.

Parameter	QC Check	Frequency	Acceptable Range	Correction Actions
Equipment Blank	Cross contamination from equipment rinsing between samples	1/trip for filtered nutrients only performed during middle of run	non detect	Notify staff, repeat procedure, find contamination source, decide to accept or reject data
DO	Written record of calibration	Daily before use	Instrument specific	Verify altitude; if not correct return meter to manufacturer for repair
Replicates	Required	1/20 samples	Relative percent difference of ± 20%	Notify staff if missing; audit and train; decide to allow or reject data
E. coli	Bottle at each site	Each sampling trip	Required	Audit and train
pH	2 point meter check calibration; written record of calibration	Daily before use	± 5%	Repeat field check; if not correct return meter to manufacturer for repair
Temperature	Annual calibration against	Annually	On the calibration mark	Repeat measurement with different thermometer; if not correct return

	NIST thermometer			meter to manufacturer for repair
Specific Conductance	2-point calibration and 1-point check; Written record of calibration	Daily before use	± 5%	Repeat field check; if not correct return meter to manufacturer for repair

Laboratories and Sample Handling Procedures

Laboratories

A variety of sample types will be collected during this study, requiring multiple analyzing laboratories.

Water chemistry samples will be analyzed by the Chemical and Environmental Services Bureau of the State of Utah's Public Health Laboratories (hereafter referred to as the State Lab). The State Lab maintains an in-house QAPP, available from the QAO (James Harris) or the QA/QC staff (Toby Hooker).

UPHL has limited capacity for processing $cBOD_5$ samples; therefore when the State lab cannot process the $cBOD_5$, DWQ will use ChemTech-Ford. Table 14 summarizes the corresponding laboratories that will be used in this study. All sampling procedures, analytical methods, and quality assurance requirements are found in the QAPP in Appendix G.

Phytoplankton samples will be returned to Rushforth Phycology, LLC.

Table 14. Analysis and Laboratories.

Analysis	Laboratories	Contact	Phone
Water Chemistry (and metals)	UPHL	David Dick	801-965-2405
$cBOD_5$	ChemTech-Ford (optional)	Dave Gayer	801-262-7299
Chlorophyll-a	UPHL	David Dick	801-965-2405
Phytoplankton samples	Rushforth Phycology, LLC	Sam Rushforth	801-376-3516
Cyanobacteria samples	UDWQ and State lab	David Dick	801-965-2405
E. coli	UDWQ laboratory	Calah Worthen	801-536-4376
Field Readings (Hydrolab Reading)	On site	Suzan Tahir	309-868-2834
Pressure Transducers	On site	Suzan Tahir	309-868-2834
Secchi Depth	On site	Suzan Tahir	309-868-2834
Flow Measurements	On site	Suzan Tahir	309-868-2834

Sample Handling

It is the responsibility of the field crew to coordinate with laboratory staff to obtain their own sample bottles at least one week in advance. Samples should not be shipped or delivered to the labs unless they have been informed two days in advance. Water chemistry, phytoplankton, cyanotoxins samples and bacteriological

samples (*E. coli*) will be stored in coolers. After sample collection and compilation, it is the responsibility of the field crew to turn in samples to the appropriate laboratories for analysis.

ChemTech-Ford requires Chain of Custody form to be filled out after sample collection. Sample bottles used in this study need to be handled with care in order to protect the integrity of the sample. All bottles and paperwork shall be reviewed for discrepancies and corrected before leaving samples in the laboratory's custody.

UDWQ's laboratory liaison and database manager are Toby Hooker and Lenora Sullivan, respectively (see Table 14). They work directly with DWQ's lab liaison regarding water samples and sample data submitted by DWQ.

All data results from the laboratory will be reviewed and stored by the database manager and/or lab liaison. This includes: chemistry data master logs, electronic lab sheets (from submitted samples), and analysis reports. Data from water samples take approximately 4-6 weeks from submittal to reporting.

Data Management

Data Review and Validation

UDWQ staff will be responsible for receiving the lab and field data sheets, checking for omissions in identification, decimal placement, dates, times, units reported, and comments. Water quality technical staff collecting data will be contacted immediately if there are data gaps or if scheduled sampling times were missed.

It is the water quality technical staff's responsibility to evaluate raw data generated by the contract laboratories for appropriate data summary, data quality, and accuracy. All data will be reviewed and reported in units specified at the detection level of the analysis methods used. To reduce data point loss, data that is reported as "less than" detection level should be incorporated at a value of 1/2 the detection level. Once data is generated, it will be compiled in a database file. During this data transfer, the information will be reviewed and verified in accordance with data quality objectives.

Data generated in the laboratory will be validated by performance checks such as a duplicates and blanks. Data will be reported in the units that have been designated to each parameter in the Analytical Methods, Holding Times, Parameters, and Sample Collection Methods section tables. Scientific notation will be used and significant figures will correlate with detection levels.

Data Management and Analysis

UDWQ staff proficient in water quality monitoring will organize and all lab reports and field data. DWQ Project Manager will be responsible for analyzing the data and prepare as necessary, annual reports. The findings of the annual report will be utilized to determine if the goals and objectives of the watershed program are being met and what, if any, modifications to the sampling analysis plan are necessary. Annual monitoring reports will be provided to the Utah Lake Science Panel.

Quality Control

QA/QC samples will be collected as part of UDWQ's monitoring run. It will consist of an Equipment Blank, Trip Blank and a duplicate sample. Trip Blank will be collected at the beginning of the run by filling Deionized water in all appropriate bottles (General Chemistry, Non-filtered Nutrients, Dissolved (Filtered) Nutrients, Non-filtered metals, and Filtered metals). The equipment blank will be assigned a STORET 4930015.

The equipment blank will be collected between sites in the field to ensure proper equipment rinsing between samples. Deionized water will be run through the filtering apparatus and collected in the appropriate filtered bottle (nutrients and metals) and chlorophyll-*a* sample. The equipment blank will have an assigned STORET 4930009 and will be treated identically to the samples collected in the field.

A field duplicate will be collected at Utah Lake 0.5 mile W of Geneva Discharge#15-A STORET 4917310 and the duplicate will be called Utah Lake 0.5 mile W of Geneva Discharge#15B with a STORET 4917320. See Table Table 4 for an overview of all Utah Lake sites.

References

1. EPA. 2006a. ***Guidance on Systematic Planning Using the Data Quality Objectives Process.*** EPA QA/G-4, EPA/240/B-06/001, U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC.

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5. Roslev, P., and Bukh, A. S. 2011 State of the Art Molecular Markers for Fecal Pollution Source Tracking in Water. Appl Microbiol Biotechnol 89: 1341-1355

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Appendix

Appendix A: ***Field Forms and Hydrolab sheets***

Field Sheet for Open Water Sites

UTAH LAKE 2018			
Trip Name: UT LK	☐ Discrete Site Visit (non-routine)		
Sample Date:	**Sample Time:**		
Site Name:	**Site STORET:** 4917600		
GOSHEN BAY SOUTHWEST END			
TRIP OR EQUIPMENT BLANK	**Samplers:**		
☐ Y	☐ ST ☐ BS		
Field Observations (IGNORE IF TRIP OR EQUIPMENT BLANK)			
Total Depth (cm):			
Water Clarity:	Secchi Disk Depth:		
Algal Mats:	Current Weather:		
Other Notes:			
Photos Taken? ☐ Y ☐ N			
Photo Numbers:	Description:		
Missing Samples (include sample type and brief explanation):			
Routine Sample Checklist:			
☐ Hyrolab Reading			
☐ Ch-a_____mL	☐ Filtered Metals		
☐ Total Chem	☐ Phytoplankton		
☐ Nutrients (non Filt)	☐ Cyanotoxin		
☐ Filt. Nutrients	☐ E.coli		
Reviewed: Monitor _____	Date: _____		

UTAH LAKE 2018			
Trip Name: UT LK	☐ Discrete Site Visit (non-routine)		
Sample Date:	**Sample Time:**		
Site Name:	**Site STORET:** 4917500		
UTAH LAKE 3 MI WNW OF LINCOLN BEACH			
TRIP OR EQUIPMENT BLANK	**Samplers:**		
☐ Y	☐ ST ☐ BS		
Field Observations (IGNORE IF TRIP OR EQUIPMENT BLANK)			
Total Depth (cm):			
Water Clarity:	Secchi Disk Depth:		
Algal Mats:	Current Weather:		
Other Notes:			
Photos Taken? ☐ Y ☐ N			
Photo Numbers:	Description:		
Missing Samples (include sample type and brief explanation):			
Routine Sample Checklist:			
☐ Hyrolab Reading			
☐ Ch-a_____mL	☐ Filtered Metals		
☐ Total Chem	☐ Phytoplankton		
☐ Nutrients (non Filt)	☐ Cyanotoxin		
☐ Filt. Nutrients	☐ E.coli		
Reviewed: Monitor _____	Date: _____		

Hydrolab Sheet for Open Water Sites

Seq #	Project	Station ID	Station Name	Date mm/dd/yy	Time hh:mm	Temp (ºC)	pH	SpC (µS/cm)	DO (mg/L)	Total Depth (m)	Secchi Depth (m)
1	302	4917310	Utah Lake 0.5 mi West of Geneva Discharge #15-A								
2	302	4917320	Utah Lake 0.5 Mile West Of Geneva Discharge #15-B								

Field Sheet for Inflow Sites

UTAH LAKE 2018		UTAH LAKE 2018	
Trip Name: UT LK	☐ Discrete Site Visit (non-routine)	**Trip Name:** UT LK	☐ Discrete Site Visit (non-routine)
Sample Date:	**Sample Time:**	**Sample Date:**	**Sample Time:**
Site Name:	**Site STORET :**	**Site Name:**	**Site STORET :**
BEER CREEK/BENJAMIN SLOUGH	4995465	SPANISH FORK RIVER AT UTAH LAKE INLET	4995578
TRIP OR EQUIPMENT BLANK	**Samplers:**	**TRIP OR EQUIPMENT BLANK**	**Samplers:**
☐ Y	☐ ST ☐ BS ☐ ☐	☐ Y	☐ ST ☐ BS ☐ ☐
Field Observations		**Field Observations**	
Water Clarity:		Water Clarity:	
Algal Mats:	Current Weather:	Algal Mats:	Current Weather:
Phragmites:		Phragmites:	
Other Notes:		Other Notes:	
Photos Taken? ☐ **Y** ☐ **N**		**Photos Taken?** ☐ **Y** ☐ **N**	
Photo Numbers:	Description:	Photo Numbers:	Description:
Missing Samples (include sample type and brief explanation):		**Missing Samples (include sample type and brief explanation):**	
Routine Sample Checklist:	**Other Samples**	**Routine Sample Checklist:**	**Other Samples**
☐ Hyrolab Reading	☐ Flow	☐ Hyrolab Reading	☐ USGS Flow
☐ Ch-a_____mL	☐ Pressure Transducer	☐ Ch-a_____mL	☐ Pressure Transducer
☐ Total Chem	☐ E.coli	☐ Total Chem	☐ E.coli
☐ Nutrients (non Filt)		☐ Nutrients (non Filt)	
☐ Filt. Nutrients		☐ Filt. Nutrients	
☐ $cBOD_5$			
Reviewed: Monitor _____ Date: _____		**Reviewed:** Monitor _____ Date: _____	
Data Manager: _____ Date:		Data Manager: _____ Date:	

Hydrolab Sheet for Inflow Sites

Seq #	Project	Station ID	Station Name	Date mm/dd/yy	Time hh:mm	Temp (°C)	pH	SpC µS/cm	DO (mg/L)	Flow (cfs)	E/M
1	302	4995465	BEER CREEK/BENJAMIN SLOUGH								
2	302	4995578	SPANISH FORK RIVER AT UTAH LAKE INLET								

Appendix B: ***Lab Sheets***

LAB Sheet for Open Water sites

Utah Division of Water Quality
Cooperative Monitoring Program

Monitoring Run **Utah Lake** Sequence Number **1**
Trip ID **UTLK051518** Agency **1**
Collector **Suzan Tahir Dax Reid** Project Code **302**

Sampler Contact Information (name and phone number): **Suzan Tahir 309-868-2834**

Monitoring Location ID: **4917600** Time:

Description: **UTAH LAKE GOSHEN BAY SOUTHWEST END** Date: **05-16-18** MM - DD - YY

Field Specific Conductance (µS/cm): . Sample Type **4**

TEST REQUESTS:

Chemistry **Partial List: ALK, CL, COND, SO4, TDS, TSS, TURB, TVS**	1	Temp:	pH:	Comments:	
Non-Filtered Nutrients **Partial List: NH3, NO32,TN, TOC, TPO4**	1	Temp:	pH:	Comments:	
Filter Nutrients **Partial List: NH3, NO32,TN, TOC, TPO4**	1	Temp:	pH:	Comments:	
Filter Metals **Partial List: CA, K, MG, NA**	1	Temp:	pH:	Comments:	
CH-A (Water) Partial List: **PHEO, HPLC**	1	Temp:	pH:	Comments:	

Site Notes

FIELD COMMENTS: Weather Conditions: Field Conditions:

Sheen present?: ☐ Y ☐ N Trash near sampling site? ☐ Y ☐ Algal mat at site? ☐ Y ☐ N
Wildlife/Livestock near sampling site? ☐ Y ☐ N Recent rain or other precip. in the past 48 hours? ☐ Y ☐ N

Anthropogenic disturbances present at site that may affect sample results? ☐ Y ☐ N
(i.e. construction; car-bodies on stream bank; swimming, etc.)
If yes to any above, explain here:

Were all lab samples collected at this site as indicated on lab sheet? ☐ Y ☐ N
If no, explain which samples were not collected and why:

Were all sonde parameters collected at site? ☐ Y ☐ N
If no, which ones were NOT collected and why:

Were any photos taken at site this visit? ☐ Y ☐ N

LAB Sheet for Inflow sites

Utah Division of Water Quality
Cooperative Monitoring Program

Monitoring Run: **Utah Lake**
Trip ID: **UTLK051518**
Collector: **ST BS**

Sequence Number: **12**
Agency: **1**
Project Code: **302**

Sampler Contact Information (name and phone number): **Suzan Tahir 309 868 2834**

Monitoring Location ID: **4994950**
Time:
Description: **SPRING CK BL LEHI MILL POND**
Date: **05-15-18** MM - DD - YY

Field Specific Conductance (µS/cm):
Sample Type **4**

TEST REQUESTS:

Chemistry **Partial List: ALK, CL, COND, SO4, TDS, TSS, TURB, TVS**	1	Temp:	pH:	Comments:	
Non-Filtered Nutrients **Partial List: NH3, NO32,TN, TOC, TPO4**	1	Temp:	pH:	Comments:	
Filter Nutrients **Partial List: NH3, NO32,TN, TOC, TPO4**	1	Temp:	pH:	Comments:	
CH-A (Water) **Partial List: PHEO, HPLC**	1	Temp:	pH:	Comments:	

Site Notes

FIELD COMMENTS:
Weather Conditions:
Field Conditions:

Sheen present?: ☐ Y ☐ N
Trash near sampling site? ☐ Y ☐ Algal mat at site? ☐ Y ☐ N
Wildlife/Livestock near sampling site? ☐ Y ☐ N
Recent rain or other precip. in the past 48 hours? ☐ Y ☐ N

Anthropogenic disturbances present at site that may affect sample results? ☐ Y ☐ N
(i.e. construction; car bodies on stream bank; swimming, etc.)
If yes to any above, explain here:

Were all lab samples collected at this site as indicated on lab sheet? ☐ Y ☐ N
If no, explain which samples were not collected and why:

Were all sonde parameters collected at site? ☐ Y ☐ N
If no, which ones were NOT collected and why:

Were any photos taken at site this visit? ☐ Y ☐ N

Appendix C: ***Chain of Custody (COC) Forms***

Phytoplankton samples COC

UTAH DIVISION OF WATER QUALITY				PHYTOPLANKTON CHAIN OF CUSTODY RECORD (Rushforth Phycology, LLC)		
PROJECT: Clean Lakes				**Sample Collection Method:** Grab Sample	**Preservation:** Refrigerated	
Sample Date Range:					**Analysis Requested:** Quantitative phytoplankton ID	
Sample Number	**Date Collected**	**Time Collected**	**STORET**	**Site Name**	**Collector Initials**	**Remarks**
Relinquished By:				**Date:**	**Time:**	**REMARKS:**
Received By:				**Date:**	**Time:**	

Page _____ of _____

Phytoplankton HAB samples COC

Rushforth Phycology Chain of Custody: HARMFUL ALGAL BLOOM

Record of Field Data for Samples Delivered for HAB Phytoplankton Analysis

Information provided on this form must be identical to information provided on sample bottles. If preprinted labels are not used, detailed sample information must be legibly written on dry sample bottles in permanent, non-smearing ink. This is critical for proper tracking of samples and data.

RESPONSIBLE ENTITY: **Contact Information:**	**HARMFUL ALGAL BLOOM (CyanoHAB)**
Sampling Area:	**Analysis:** Cyanobacteria only
Sample Collection Types*: please indicate 1 or 2 for each sample. 1. Surface Grab. Collection of mat or film material at water's surface 2. Composite Grab. Compilation of several samples taken from ~ elbow-depth to surface.	If you're delivering for DWQ/SLC/SLCH/UCHD and have been cleared to request **Priority Turnaround** please **indicate here AND** on the **sample bottle**. Please record delivery time in signature line.

Sample Number	Date Collected	Site Name	Sample Type*	Site Specifics or Lat/Long	Collector Name	Priority
Delivered By:			**Date:**		**Time:**	
Received By:						

CHEMTECH-FORD Analytical Laboratory COC

CHEMTECH - FORD ANALYTICAL LABORATORY

CHAIN OF CUSTODY

COMPANY: _____
ADDRESS: _____
CITY/STATE/ZIP: _____
PHONE #: _____ FAX: _____
CONTACT: _____ PROJECT: _____
EMAIL: _____

BILLING ADDRESS: _____
BILLING CITY/STATE/ZIP: _____
PURCHASE ORDER #: _____

CHEMTECH-FORD LABORATORIES

TURNAROUND REQUIRED:* _____
* Expedited turnaround subject to additional charge

Lab Use Only	CLIENT SAMPLE INFORMATION					TESTS REQUESTED																Bacteria			
	LOCATION / IDENTIFICATION	DATE	TIME	MATRIX	Field: Residual Chlorine																	Total Coliform + E. coli (Present/Absent)	Total Coliform + E. coli (Enumerated)	HPC (Plate Count)	E. Coli Only
	1.																								
	2.																								
	3.																								
	4.																								
	5.																								
	6.																								
	7.																								
	8.																								
	9.																								
	10.																								

Sampled by: [print] | Sampled by: [signature]

ON ICE NOT ON ICE Temp (C°):

Special Instructions:

Samples received outside the EPA recommended temperature range of 0-6 C° may be rejected.

Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time

CHEMTECH-FORD
9632 South 500 West
Sandy, UT 84070

801.262.7299 PHONE
866.792.0093 FAX
www.chemtechford.com

Payment Terms are net 30 days OAC. 1.5% interest charge per month (18% per annum). Client agress to pay collection costs and attorney's fees.

Appendix D: ***UT DWQ Algal Bloom Report Form***

UT DWQ Algal Bloom Report Form

Please provide information about the potential blue-green algae bloom observed.
Please remember to include digital photographs as additional documentation (close-up, and landscape showing extent and location of bloom). Also, if you don't have ability to collect GPS coordinates, please include an image from an online mapping application such as Google, Bing or Yahoo Maps, with a marker at the bloom location.

Bloom Location:

Waterbody:	Date bloom observed: / /
County (optional):	Drinking Water Source? Yes ☐ No ☐ Unknown ☐
Publicly Owned Lake? Yes ☐ No ☐ Uncertain ☐	Attached map with bloom location noted (e.g. Google Map image)? Yes ☐ No ☐ Digital photos attached? Yes ☐ No ☐

Report Completed By:

Name:	Organization:	
Title:	Phone: ( )	Email:

Bloom Description and Sampling Information:

Please describe the location of the bloom in the water body (e.g. center of lake, at the boat dock, at the beach):

Do you notice any colors in the water column? Yes ☐ No ☐
Please check any colors you see, or describe the color(s) below:
Green ☐ Blue ☐ Red ☐ Rust ☐ Brown ☐ Milky White ☐ Purple ☐ Black ☐
Other:

Please estimate the size (sq. feet) or the extent of bloom (e.g., percent of lake):

Can you see a surface scum (an accumulation at the surface) or algae floating near the water surface?
Algae floating at the surface can look like grass clippings, green cottage cheese curds, or spilled paint.
Yes ☐ No ☐ Uncertain ☐

Is the bloom near a public beach? If yes, please specify the beach name or location:
Yes ☐ No ☐ Uncertain ☐

Is the bloom near a drinking water intake? (Specify water system name if known):
Yes ☐ No ☐ Uncertain ☐

Were samples taken? Yes ☐ No ☐
If yes, what type of samples; when and where were they collected; and where were they sent for analysis?

Do you know if other water quality information is available? (Specify what data is available and where): Yes ☐ No ☐

Please provide additional observations if available e.g., smells, dead fish/birds, public witness accounts and contact info:

Form adapted from OH EPA

Appendix E: Hydrolab Calibration Sheet

Utah Division of Water Quality
Monitoring Section

Sonde Calibration Report

Date/Time: _____ Analyst(s): _____ Location: _____
Run (Trip ID): _____ Sonde Make & Model: _____
Handheld Type: _____ Sonde Name: _____

Specific Conductance

! Calibration Point Should Reflect Field Values Range !

Calibration Point (µS/cm@25°C)	Buffer Solution Value	Buffer Solution Exp. Date	Pre-Cal. Reading	Post Cal. Reading
0 (zero)	*air*	*n/a*		
Std.				

On-site Recalibration performed? Y* or N (circle one)
*Recalibrations recorded at bottom of sheet

Certified Check Buffer				±5% of expected? Y or N (circle one)

pH

! Calibration Points Should Reflect Field Values Range !

Calibration Point	Solution Temp (°C)	Buffer Value (from chart)	Buffer Exp. Date	Pre-Cal. Reading	Post Cal. Reading
4.00					
7.00					
10.00					

On-site Recalibration or Calibration Check performed? Y* or N (circle one)
*Recalibrations recorded at bottom of sheet

Certified Check Buffer					±5% of expected? Y or N (circle one)

Dissolved Oxygen

Local/Actual Barometric Pressure (mm/Hg)	Pre-Cal. % Saturation	Post Cal. % Saturation

On-site Recalibration performed? Y* or N (circle one)
*Recalibrations recorded at bottom of sheet

Date / Time/Battery

Today's Date	Watch Time (24 Hour)	Surveyor Date	Surveyor Time	Date/Time Adjusted ?		Surveyor Battery Charged ?	
				Yes	No	Yes	No
				☐	☐	☐	☐

Recalibrations / Calibration Checks[#]

MLID	Probe Type (circle one)	Recalibration (RC) or Calibration Check (CC)	Reason	Calibration Point[$] (or BP for DO)	Pre-Cal. Reading	Post Cal. Reading	Check ± 5% of expected? (Y or N)
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						
	SC pH DO						

[#]Assumes buffers used for recalibrations are those used for initial calibration. Note if buffer used has different expiration date than listed above.

[$]Be sure to use temperature-compensated pH buffer value based on temp. of buffer at time of recalibration/check.

Problems or Remarks

Specific Conductance Check Buffer Acceptability Range

SC Buffer Value	Acceptable 5% Range
100 µS/cm@25°C	95 - 105
500 µS/cm@25°C	475 - 525
1413 µS/cm@25°C	1342 - 1483
3000 µS/cm@25°C	2850 - 3150
20000 µS/cm@25°C	9500 - 10500

pH Buffer Solution Temperature Correction and Check Buffer/On-site Calibration Check Acceptability Range

pH 4.00			pH 5.80		
°C	Value	Acceptable 5% Range	°C	Value	Acceptable 5% Range
15	4.00	3.80 - 4.20	15	5.79	5.50 - 6.08
20	4.00	3.80 - 4.20	20	5.80	5.51 - 6.09
25	4.00	3.80 - 4.20	25	5.80	5.51 - 6.09
30	4.01	3.81 - 4.21	30	5.80	5.51 - 6.09

pH 7.00			pH 9.00		
°C	Value	Acceptable 5% Range	°C	Value	Acceptable 5% Range
15	7.04	6.69 - 7.39	15	9.10	8.65 - 9.56
20	7.02	6.67 - 7.37	20	9.05	8.60 - 9.50
25	7.00	6.65 - 7.35	25	9.00	8.55 - 9.45
30	6.99	6.64 - 7.34	30	8.97	8.52 - 9.42

pH 10.00		
°C	Value	Acceptable 5% Range
15	10.11	9.60 - 10.62
20	10.05	9.55 - 10.55
25	10.00	9.50 - 10.5
30	9.95	9.45 - 10.45

From the Hach LDO Sensor Instruction Sheet:

Determine the barometric pressure for entry as the calibration standard. The barometric pressure needs to be in mmHg. 1mmHg = 0.00133322 bar = 133.322 pascal = 0.019336778 pounds/square inch [absolute].

Local Barometric Pressure, BP, in mmHG can be estimated using:

$BP' = 780 - 2.5(A_{ft}/100)$ or $BP' = 780 - 2.5(A_m/30.5)$

where:

BP' = Barometric pressure at altitude

BP=Barometric pressure at sea level

A_{ft} = Altitude in feet

A_m = ALtitude in meters

If using the local weather bureau BP, remember these numbers are corrected to sea level. To calculate the uncorrected atmospheric pressure BP', use the following equations:

$BP' = BP - 2.5(A_{ft}/100)$ or $BP' = BP - 2.5(A_m/30.5)$

where:

BP' = Barometric pressure at altitude

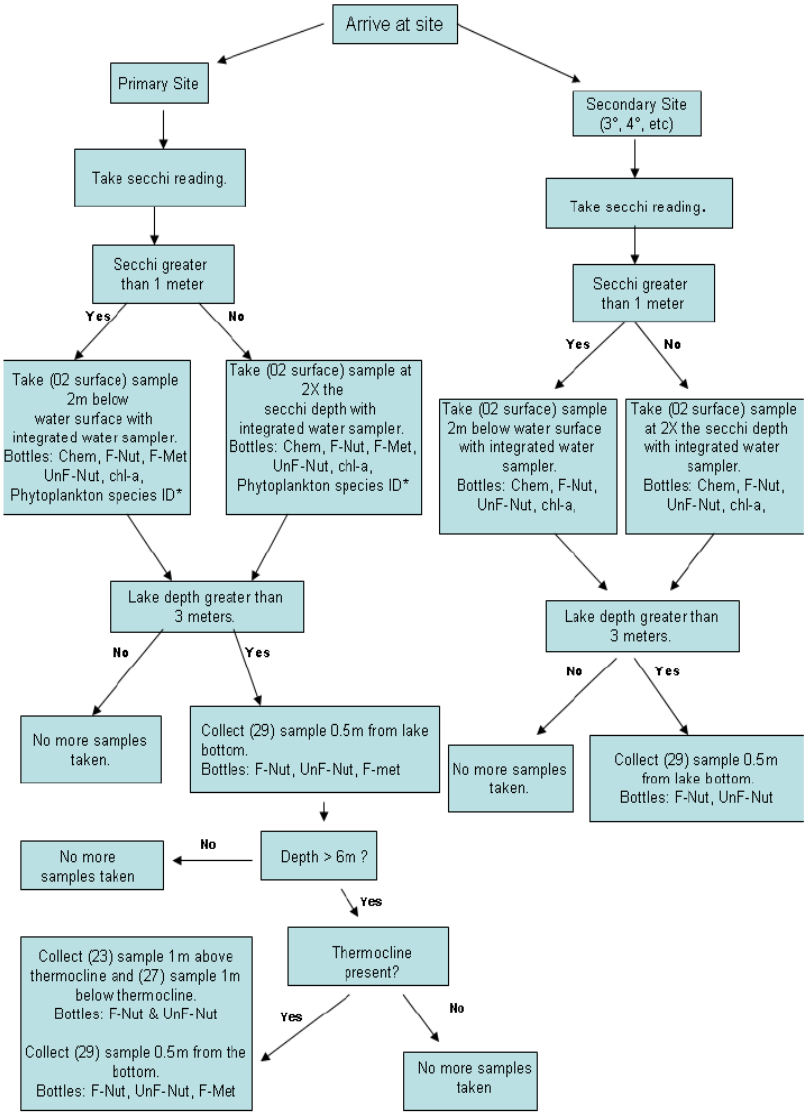
BP Converstion Factors:

Muliply BPmbar (hPa) by 0.75 to get BPmmHg

Muliply BPinHg by 25.4 to get BPmmHg

Hydrolab Series 5 sondes require BP be entered in mm Hg.

Appendix F: Lake Protocol Field Cheat Sheet



Appendix G: Quality Assurance Project Plan

https://deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/DWQ_QAPP_5.1.14_Rev0.pdf